Thermodynamic Properties of Mixtures Containing Helium or Hydrogen from a Helmholtz Energy Mixture Model

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A mixture model is presented for the calculation of the thermodynamic properties of mixtures containing helium or hydrogen with typical natural gas constituents including nitrogen, oxygen, argon, neon, carbon dioxide, carbon monoxide, deuterium, methane, ethane, propane, normal butane, isobutane, pentane, ethylene, or propylene. The model can be used for the calculation of densities, heat capacities, sound speeds, energies and vapor-liquid equilibrium properties and can be combined with mixture models developed previously in similar work on natural gas to calculate the properties of multicomponent mixtures. An extensive literature survey is given that includes most of the available experimental data. Comparisons to available experimental data are given to establish the accuracy of calculated mixture properties.